DICHOTOMOUS CHOICE CONTINGENT VALUATION WILLINGNESS TO PAY ESTIMATES ACROSS GEOGRAPHICALLY NESTED SAMPLES: CASE STUDY OF ALASKAN STELLER SEA LION

By

Branka Turcin

RECOMMENDED:

Advisory Committee Chair

Department Head

APPROVED:

Dean, School of Management

Dean of the Graduate School

12-11-01

Date

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A

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Branka Turcin, B.S.

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ABSTRACT

This thesis examines Willingness-to-Pay (WTP) for an endangered species across geographically nested samples using the Contingent Valuation Method (CVM). The samples range from the boroughs that contain critical habitat for the Steller sea lion to the state that contains these boroughs to the entire United States. Depending on the assumptions of the model, WTP varies tremendously from sample to sample. When WTP is unrestricted to the non-negative region, mean WTP for the United States is the highest and it is the lowest for the boroughs. The null hypotheses that mean WTP estimates are greater then zero were rejected for the boroughs and the state but it was not rejected for the United States based on the 95% confidence intervals. When WTP is restricted to the non-negative region, the WTP does not differ significantly from sample to sample. The estimation results may lead to dramatically different policy implications.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

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1. INTRODUCTION

Since early 1960s, when the first Contingent Valuation Method (CVM) study was conducted by Robert K. Davis in order to estimate benefits of outdoor recreation in Maine backwoods (Davis 1963), a great number of CVM studies has been undertaken in order to obtain benefit estimates for different public goods or non-market resources. Among the public goods and non-market resources in which benefits have been estimated using the CVM there has been a number of studies on rare and endangered wildlife protection policies, including some that involve decisions about species' critical habitat (Loomis and White 1996). The Steller sea lion case study involves using CVM to obtain Willingness-to-Pay (WTP) estimates for the expanded Steller sea lion recovery program in Alaska, which may be used for making future decisions on policies regarding Steller sea lion recovery program.

It is often useful to use WTP estimates of the United States for policy decision-making in regard to endangered species. Sometimes, however, it is important to obtain WTP estimates of the regions most affected by the potential policy change. While there has been prior work done on spatial differences in resource value (Pate and Loomis 1997), there is very little information in the literature about differences in WTP estimates among geographically nested samples.

In this study the counties or boroughs containing the resource being valued, the state where the counties or boroughs are located and the entire United States are disaggregated. This geographical nesting separates out areas which are affected differently by policy change. One of the important objectives of this study was to determine whether WTP estimates differed across geographically nested samples (borough, state and national levels).

Chapter 1 contains a presentation of some important issues surrounding the CVM as well as the relevant theoretical framework. Chapter 2 introduces the Steller sea lion case study and describes the CVM survey used. Finally, in chapter 3 logistic regression results, WTP estimates and their comparison across geographically nested samples are presented and discussed.

2. CONTINGENT VALUATION METHOD

The Contingent Valuation Method (CVM) is a non-market economics technique that may be used to measure benefits of changed levels of public goods. Those benefits are then compared to the costs in benefit-cost analysis, results of which might affect future policy decisions involving public goods[1].

Criteria used in benefit-cost analysis to judge policy trade-offs are either Pareto-improvement criterion or potential Pareto-improvement criterion. The former is met if after those who are better off due to the change in level of a public good have compensated those who are worse off due to that change, at least one economic agent is better off and no one is worse off. That is known as a compensation test. Even though some economists argue that using an actual compensation criterion is unrealistic, potential Pareto-improvement (or potential compensation test) has become accepted as a more realistic benefit-cost analysis alternative criterion. Definitions of benefits, as well as ways of measuring them, have changed over time. Today it is widely accepted that in attempting to measure benefits of public goods all benefits that could legitimately occur should be included in the assessment.

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[1]Public goods in this context mean both quasi-private and pure public goods. As defined by Kopp and Portney (1985) quasi-private goods, such as hunting permits issued by states, are those that are not freely traded in competitive markets but are in all other characteristics the same as pure private goods, which means that potential consumers can be excluded and individual property rights are identified. Pure public goods, on the other hand, are not traded in any organized market, they cannot exclude potential consumers and individual property rights are not identified.

Total value should encompass use and non-use (passive use) values (Randall and Stoll 1983). One of the advantages of the CVM is that it is capable of measuring both use and non-use values of a public good/resource. Use value can be defined as a consumer value of a public good, or resource reserves for future use. Although it is obvious that non-use value would then be a value consumer obtains from non-consumptive, rather then from direct use of the good/resource, uniform classification of non-use value does not exist. Most commonly, non-use value is said to be composed of one or more values including existence, bequest and option values. Existence value is a value obtained from knowing that a good/resource exists and bequest value is a value obtained from knowing that a good/resource will be there for future generations to enjoy it. Bequest value is often regarded as a part of existence value. Although many authors include an option value, a value people would be willing to pay now to know that good/resource will be there if they wish to use it at some future point, as a non-use value component, some literature provides evidence why an option value should not be a part of non-use value[2].

Due to the notion that respondents themselves are not as precisely aware of the motives behind their judgments as the researchers would like them to be (Mitchell and Carson 1993), obtaining the unique estimates of different categories and subcategories of non-use values is usually not in the researcher's focus.

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[2] See Smith (1987).

Although some economists argue that values held by respondents for reasons other then the good itself, such as warm glow[3] (Arrow et al. 1993), should be extracted from the estimated total benefits of the public good/resource, separate categories of non-use values will not be estimated in this study. Reasons for that will be explained later in the thesis.

2.1. Important Points in the History of Contingent Valuation Method

As mentioned earlier, the first CVM study was conducted in the early 1960s by Robert K. Davis (Davis 1963), when he used CVM to obtain benefits of outdoor recreation in Maine backwoods. Since the early 1970s, although mostly exploratory, CVM studies have been used to measure benefits of a wide variety of public goods such as recreation, hunting, water quality and air quality among others. Researchers also concentrated on comparative studies between CVM and other non-market techniques already established as valid for measuring benefits of public goods. Bishop and Heberlein (1979) compared CVM estimates with those obtained using travel cost method and a "real" cash experiment and Brookshire et al. (1982) compared CVM estimates and actual observed property values. These studies have shown that CVM WTP estimates are at most 25% greater then WTP obtained with actual behavior methods.

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[3] Also called "impure altruism" (Andreoni, 1989, p. 1449), "warm glow" can be described as "public spiritedness" (Arrow et al. 1993, p. 4604), or the motivation of receiving benefits from contributing to the "good cause".

Since the mid-1970s, the U. S. Environmental Protection Agency has been funding research to determine the promises and problems of the CVM. In 1983, the Water Resource Council included Contingent Valuation Method (CVM) as one of three recommended methods to be used in determining benefits of federal projects for the projects' evaluations (Water Resource Council 1983). In late 1980s CVM was upheld by the United States courts (State of Ohio v. Department of Interior, 880 F.2d 432 (D. C. Cir. 1989)). In 1993, the National Oceanic and Atmospheric Administration (NOAA) set up a "blue-ribbon" panel, which included two Nobel laureate economists, an environmental economist and a survey research specialist, who formed a list of recommendations for future CVM use and research. The panel, also, concluded that CVM can produce estimates reliable enough to be the starting point for administrative and judicial determinations (Arrow et al. 1993).

2.2. Format of Contingent Valuation Method

CVM uses questionnaires to elicit either WTP or Willingness-to-Accept (WTA) for the change in a good or service. Studies have shown that hypothetical WTA estimates are likely to be biased upward, if compared to the "true values obtained from a market-like auction," and that WTP estimates more closely correspond to those "true values" then do the WTA estimates (Cummings et al. 1986, p. 37-48). For that reason CVM questionnaires are more often designed in a way to elicit WTP estimates.

WTP format was also recommended by the NOAA's "blue-ribbon" panel as well as by Bishop and Heberlein (1979). The best CVM questionnaire, recommended also by the panel, is considered to be the one that resembles the actual political referendum because it most closely resembles the actual respondent's decision-making process, which occurs when a respondent is asked to evaluate a change in a good or policy. Referendum model assumes that people make choices, which are influenced by multiple motives, contextual factors, and by less then perfect information (Mitchell and Carson 1993).

The CVM questionnaire creates a hypothetical market for the public good in question. Therefore, relevant information about the public good, that should help respondents make somewhat informed decision when answering the WTP question, needs to be included in the questionnaire. Respondents are expected to make a decision about the CVM referendum proposition as if the CVM questionnaire were a real and not hypothetical referendum proposition.

There are numbers of ways in which elicitation question can be formulated, but dichotomous choice referendum style (DCRS) question and the double-bounded dichotomous choice referendum style question (double-bounded DCRS) are the ones most commonly used.[4]

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[4] For other elicitation methods see Mitchell and Carson (1993).

DCRS question can be formulated as follows:

If "a public good G" were the only issue on the next ballot and it would cost your household $x, would you vote in favor of it?

❒ *Yes* ❒ *No*

Double-bounded DCRS question can be formulated as follows:

If "a public good G" were the only issue on the next ballot and it would cost your household $x, would you vote in favor of it?

❒ *Yes* ❒ *No* → *Would you be willing to pay $x-b?*

❒ *Yes* ❒ *No*

↓

Would you be willing to pay $x+a?

❒ *Yes* ❒ *No*

$x is usually referred to as a bid amount, $a is an increment by which $x is increased to propose a new and higher bid amount, if respondent voted "yes" to the first question, and $b is an increment by which $x is decreased to propose a new and lower bid amount, if respondent voted "no" to the first question. The range of the bid amount is determined based on questionnaire's pre-testing and values are randomly assigned to the respondents.

Although DCRS format directly corresponds to the judgments voters are asked to make when voting in "real" referenda, Hanemann et al. (1991) have shown that DCRS format results in less efficiency in the estimated WTP parameters, if compared to those obtained using double-bounded DCRS format. On the other hand, studies have also shown that when conducting a CVM survey through mail questionnaire (as opposed to in-person interview), respondents are more likely to engage in strategic behavior when presented with double-bounded DCRS then when they are presented with DCRS question (Loomis, personal communication). These findings should be kept in mind when deciding on the format of the CVM WTP elicitation question.

2.3. Theoretical Framework Underlying Contingent Valuation Method

The following section is a brief overview of the welfare theory. Welfare theory is the underlying theoretical base for the WTP estimates. However, the line that can be drawn between theoretical welfare measures and the estimates that can be obtained from experimental studies is often vague.

Estimates obtained in practice may not correspond with theoretical concepts. Because of the hypothetical and ad hoc nature of such experimental studies, it is often times hard to distinguish what it was that was really measured and captured by the study. Nevertheless, some common ground between the theoretical framework of the welfare theory and WTP estimates does exist. For this reason the following text focuses on describing the main ideas and basic terminology of the welfare theory.

2.3.1. Consumer surplus

When there is a change in a public good *G,* individuals may experience a change in welfare. It is often a goal of economists to measure that welfare change. If a consumer is worse off due to a policy change, the difference in her/his utility before and after the change will be negative. If, on the other hand, a consumer is better off due to a policy change, the difference in her/his utility before and after the change will be positive. The later would represent benefits consumer received due to the policy change.

A traditional measure of welfare change is consumer surplus (CS). Suppose that a policy change shifts the price of a good from p_0 to p_1. Then, following Varian (1992), consumer surplus is given by an area under Marshallian demand curve $q(p, I)$, which is a function of price p and income I, and between prices p_0 and p_1. Thus,

$$CS = \int_{p_0}^{p_1} q(p)dp \qquad (1)$$

The area is shown in Figure 1.

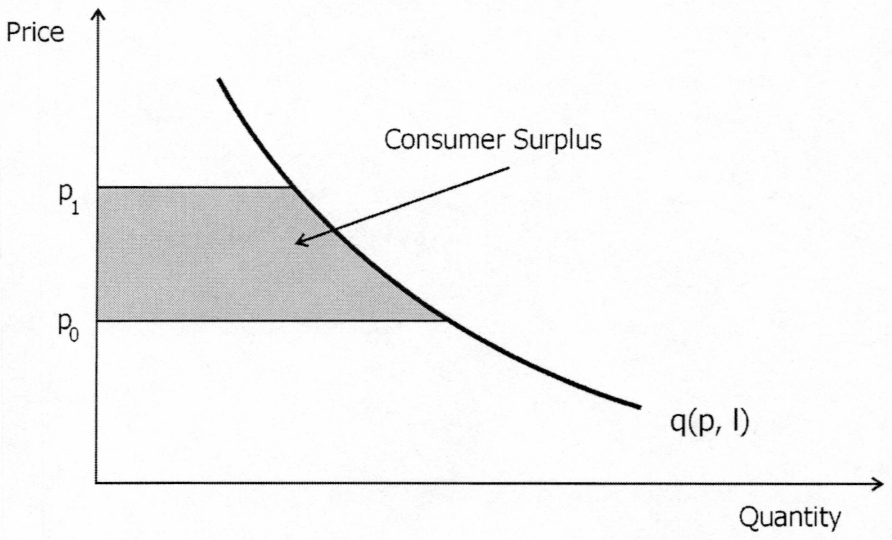

Figure 1 Consumer Surplus

If consumer's utility function is quasi-linear, which means that one of the goods in utility function has linear relationship with utility, while other goods might have non-linear relationships, then consumer surplus is an exact measure of welfare change. If all consumers have quasi-linear utility functions, the area below aggregate demand function and between prices p_0 and p_1 would be aggregate consumer surplus. Although it is not very likely that all consumers have quasi-linear utility functions, aggregate consumer surplus is often used in practice as a measure of change in consumer's welfare (Varian 1992). Since consumer surplus holds income constant, rather than the utility level, it is not an exact measure of welfare change.

Valid measures of welfare change are considered to be equivalent variation and compensating variation, both of which hold utility constant.[5]

2.3.2. Equivalent Variation

Equivalent variation (EV) positions consumer on a new utility curve u_1, and by using status quo p_0 as the base, "it asks what income change would be equivalent to the proposed change in terms of its impact on utility" (Varian 1992, p. 161). In other words, it represents the minimum or maximum amount of money that must be given to or taken from a consumer to make her/him as well of as she/he would have been *after* a decrease or increase in price (Johansson 1993). Equivalent variation welfare measure is given by the area under the Hicksian demand curve $h(p,u_1)$ and between prices p_0 and p_1. Thus,

$$EV = \int_{p_0}^{p_1} h(p,u_1)dp \qquad (2)$$

which can be seen in Figure 2.

EV can also be derived as shown in Figure 3. Two convex curves on Figure 3 are old and new indirect utility functions, u_0 and u_1 respectively, whereas p_0 and p_1 represent old and new prices i.e. old and new budget constraints. Dashed line is a projection of an old price p_0 onto a new indirect utility curve u_1. Equivalent variation can be measured on y-axis between p_0 on u_0 and p_0 on u_1.

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[5] For other, less frequently used measures, see Mitchell and Carson (1993).

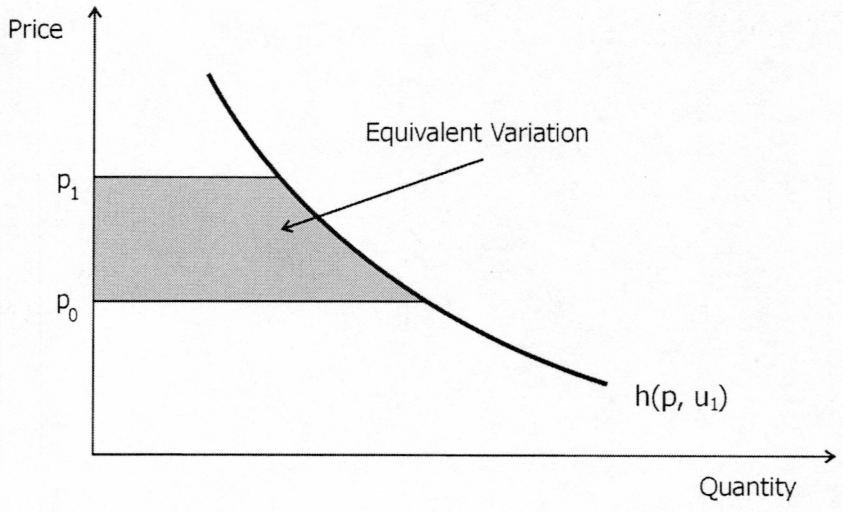

Figure 2 Equivalent Variation

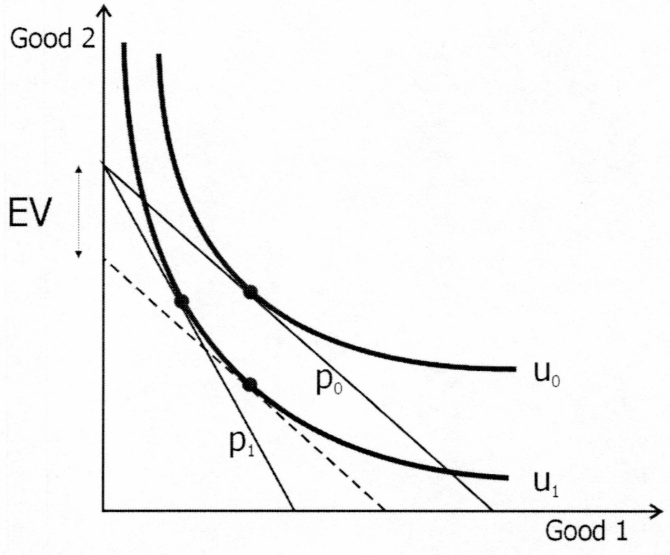

Figure 3 Indirect Utility and Equivalent Variation

2.3.3. Compensating Variation

Compensating variation holds consumer on his current utility curve u_0 and while using new price p_1 as the base "it asks what income change would be necessary to compensate consumer for the price change" (Varian 1992, p. 161). Compensating variation represents maximum or minimum amount of money that can be taken from or that must be given to a consumer in order to make her/him as well off as she/he was *before* a decrease or increase in price (Johansson 1993). Compensating variation welfare measure is given by the area under Hicksian demand curve $h(p,u_0)$ and between prices p_0 and p_1. Thus,

$$CV = \int_{p_0}^{p_1} h(p,u_0)dp \tag{3}$$

which can be seen in Figure 4.

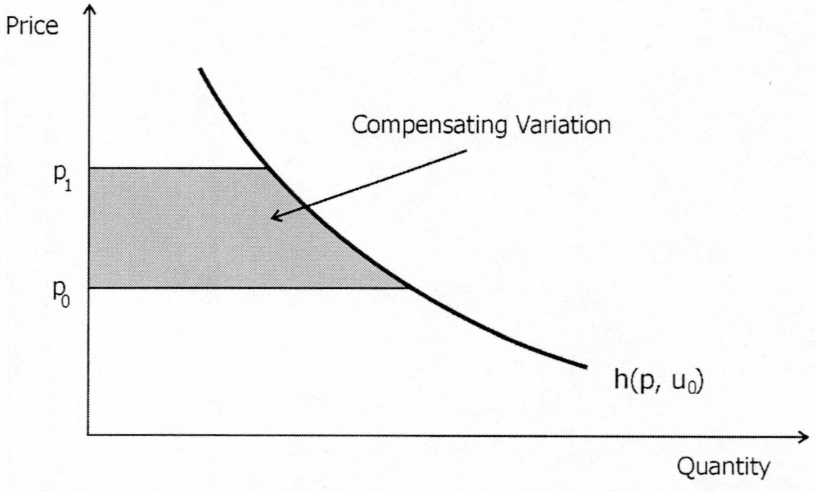

Figure 4 Compensating Variation

Figure 5 shows u_0 and u_1, p_0 and p_1 and a dashed line, which is a projection of a new price p_1 onto an old indirect utility curve u_0. Compensating variation can be measured on y-axis between p_1 on u_0 and p_1 on u_1.

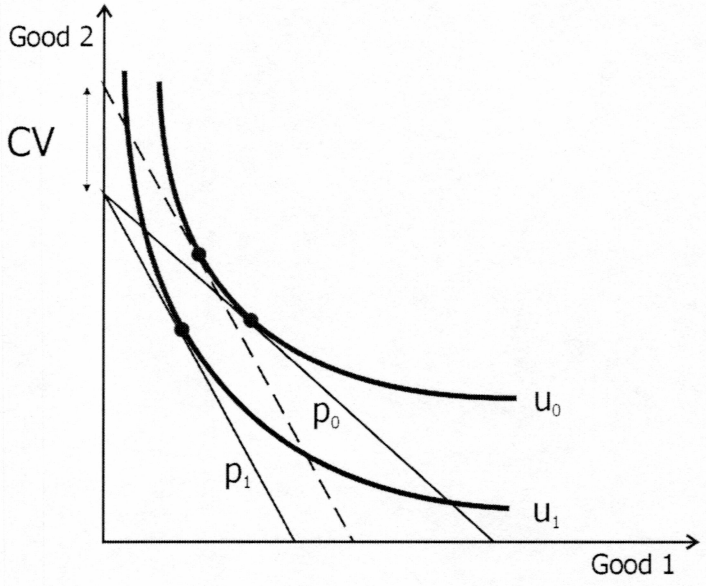

Figure 5 Indirect Utility and Compensating Variation

2.4. Theoretical Framework for Dichotomous Choice Willingness-to-Pay Estimates

This section examines the theoretical framework that directly underlies WTP estimation, in particular the one that underlies the dichotomous choice WTP estimation. There exist two basic parametric approaches for estimating WTP for public good from CV referendum data. One approach develops from utility-maximizing choice model and views referendum data as binary choice data (Hanemann 1984), while the other approach is "based upon the premise that if we could measure valuation exactly, we would use it explicitly in a regression-type model" (Cameron 1988, p. 359).

Using either approach yields similar WTP estimates.

2.4.1. Binary Choice Model

Suppose individual n is faced with a choice between two alternatives from a choice set $Cn = \{i, j\}$, where alternative i represents choosing to vote "yes" for tax payment of $\$A$ for public good G and alternative j represents choosing to vote "no" for tax payment of $\$A$ for public good G. Individual n derives utility U_{in} by choosing alternative i and U_{jn} by choosing alternative j. Following Hanemann (1984) $G = 1$ if i and $G = 0$ if j. Assuming consumer equilibrium utilities U_{in} and U_{jn} can be formulated as follows:

$$U_{in} = V_{in} + e_{in} = v(1, I_n - A_n, S_n) + e_{in} \tag{4}$$

$$U_{jn} = V_{jn} + e_{jn} = v(0, I_n, S_n) + e_{jn} \tag{5}$$

where V_{in} and V_{jn} are assumed nonrandom, systematic components of the U_{in} and U_{jn} respectively, while e_{in} and e_{jn} are assumed random components of the U_{in} and U_{jn} respectively. S_n represents vector of observable attributes of individual n that might affect her/his preferences, A_n represents tax payment of $\$A$ that respondent n can pay for the public good G, and I_n represents income.

The probability of individual n choosing alternative i is then defined as

$$P_n(i) = Pr(U_{in} \geq U_{jn})$$

$$= Pr(V_{in} + e_{in} \geq V_{jn} + e_{jn})$$

$$= Pr\{v(1, I_n - A_n, S_n) + e_{in} \geq v(0, I_n, S_n) + e_{jn}\}$$

$$= Pr\{e_{jn} - e_{in} \leq v(1, I_n - A_n, S_n) - v(0, I_n, S_n)\} \quad (6)$$

The probability of individual n choosing alternative j is defined as

$$P_n(j) = 1 - P_n(i) \quad (7)$$

Under the assumption that $e_n = e_{jn} - e_{in}$ is logistically distributed, the probability that individual n will choose alternative i can be written as

$$P_n(i) = \frac{\exp^{V_{in}}}{\exp^{V_{in}} + \exp^{V_{jn}}} = \frac{1}{1 + \exp^{-(V_{in} - V_{jn})}} \quad (8)$$

which is a binary logit model.

2.4.2. Maximum Likelihood Estimates of Binary Logit Model

The log likelihood function of any particular binary choice model can be defined as:

$$L(\beta_1, \beta_2, \ldots, \beta_k) = \sum_{n=1}^{N} \left[y_{in} \log P_n(i) + y_{jn} \log P_n(j) \right] \quad (9)$$

Indicator variable $y_{in} = 1$ if individual n chooses i and $y_{jn} = 0$ if individual n chooses j. Note that relationship between and y_{in} and y_{jn} is defined simply as:

$$y_{in} + y_{jn} = 1 \quad (10)$$

If utility is linear in its parameters and if B is defined as a vector of k unknown parameters $B = [\beta_1, \beta_2, \ldots, \beta_k]$, then

$$P_n(i) = \frac{1}{1 + \exp^{-BX}} \quad (11)$$

Vector $X = [x_1, x_2, \ldots, x_k]$ consists of k significant explanatory variables in the model.

Log likelihood function of binary logit model, which is linear in its parameters, would then be defined as follows:

$$L(\beta_1, \beta_2, ..., \beta_k) = \sum_{n=1}^{N} \left\{ y_{in} \log\left(\frac{1}{1+\exp^{-BX}} \right) + (1 - y_{in}) \log\left(\frac{\exp^{-BX}}{1+\exp^{-BX}} \right) \right\} \qquad (12)$$

By partially differentiating log likelihood function with respect to each β_k (13) is obtained:

$$\frac{\partial L(\beta)}{\partial \beta_k} = \sum_{n=1}^{N} \{ y_{in} [1 - P_n(i)] - (1 - y_{in}) P_n(i) \} x_{nk}$$

$$= \sum_{n=1}^{N} [y_{in} - P_n(i)] x_{nk} \qquad k = 1, \ldots, K \qquad (13)$$

After solving a system of K equations

$$\sum_{n=1}^{N} [y_{in} - P_n(i)] x_{nk} = 0 \qquad k = 1, \ldots, K \qquad (14)$$

maximum likelihood estimates of $\beta_1, \ldots, \beta_k$ can be obtained. If the solution to the first-order conditions exists, it is a unique solution.[6]

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[6] See Ben-Akiva and Lerman (1985)

2.4.3. Willingness-to-Pay

If probability of individual *n* choosing an alternative *i* is given with

$$P_n(i) = \frac{1}{1+\exp^{-(\beta_1+\beta_2 x_2+\beta_3 x_3+\cdots+\beta_k x_k)}} \tag{15}$$

following maximum likelihood estimation of the binary logistic model (9) – (14), vector of parameters $B = [\beta_1, \beta_2, \ldots, \beta_k]$ is estimated.

Mean WTP can be estimated using the following formula (Hanemann 1989):

$$\textit{unrestricted mean WTP} = \frac{\beta_1 + \beta_3 \bar{x}_3 + \cdots + \beta_k \bar{x}_k}{|\beta_2|} \tag{16}$$

$\beta_1 + \beta_3 \bar{x}_3 + \cdots + \beta_k \bar{x}_k$ is referred to as a grand constant. It represents indirect utility function when x_2, which represents payment of *$A* (i.e. price, referred to also as a bid amount), equals zero. β_2 is the coefficient on price and it represents marginal utility of income $\left(\partial u / \partial I\right)$.

This model implies that mean WTP can assume both positive as well as negative values. When unrestricted, WTP is an area under the cumulative distribution function of individual's true maximum WTP and above the x-axis (i.e. it represents compensating variation when price equals zero).

When restricted, the area in the limits between minus infinity and zero is subtracted from the total area of the unrestricted WTP. Thus, if we wish to rule out negative values of mean WTP, we can truncate the estimate of expected WTP at zero.

Given model (15) mean WTP can then be calculated as follows (Hanemann 1989):

$$restricted\ mean\ WTP = \frac{1}{|\beta_2|} \ln\left(1 + e^{\beta_1 + \beta_3 \bar{x}_3 + \cdots + \beta_k \bar{x}_k}\right) \qquad (17)$$

The disadvantage of doing this is that we may overestimate true WTP (Hanemann 1989). It can also be theoretically inconsistent because, during the stage of estimating parameters, it is assumed that WTP can undertake both negative and positive values, while in the stage of calculating mean WTP it is assumed that WTP can undertake only positive values (Haab and McConnell 1997). Nevertheless, this approach is often used in practice as means to solve the "problem" of negative mean WTP.

3. STELLER SEA LION CASE STUDY

3.1. Background

In 1997, after a decline of 80% over 30 years, the western population of the Steller sea lion (*Eumetopias jubatus*) was listed as an endangered species, under the United States Endangered Species Act (62 Federal Register 86 (May 5, 1997), pp. 24345-24355). Reasons for the decline cannot be stated with certainty. However, National Marine Fisheries Service (NMFS), which manages Steller sea lion recovery program, believes that commercial fishing may have contributed to the decline of Steller sea lion. Commercial fisheries may compete for its prey. Thus, one of the important measures of the program is restricting fish harvesting in the designated critical habitat. Designated critical habitat encompasses areas around Steller sea lion's rookeries, haulout sites and foraging areas in the Aleutian Islands chain, Gulf of Alaska and Bering Sea[7]. In spite of the recovery program, the western population of the Steller sea lion still continues to decline. In November 2000 NMFS issued a set of new Steller sea lion protection measures, which among others consists of more restrictive fish harvesting policy (66 Federal Register 14 (January 22, 2001), pp. 7275-7327).

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[7] For more see Title 50 Code of Federal Regulations, Pt. 226.202. 2000 ed.

3.2. Contingent Valuation Method Survey

During summer and fall 2000, a CVM survey was constructed and distributed in order to estimate WTP for the Steller sea lion recovery program, which would increase restrictions on fish harvesting, and to compare WTP estimates for the program across geographically nested samples.[8] In addition to the different samples (*Boroughs sample*, *Alaska sample*, and *United States sample*), several survey treatments were used to research temporal elasticity or temporal embedding. The specific nesting and embedding structures are described in the following section.

In order to design a well-structured questionnaire, a series of eight focus groups were held in April and May of 2000 in Fairbanks and Kodiak, Alaska. Prior to undertaking the focus groups, background information on issues related to the Steller sea lion decline, its habitat and recovery program was investigated. The questionnaire was reviewed by experts in CVM survey construction, Alaskan fisheries and marine biology. Before being distributed, the survey was pre-tested on a sample of households throughout United States, especially Alaska. The Dillman Tailored Design Method (2000) was used for the mailing process. The Dillman Tailored Design Method includes sending an announcement letter prior to sending the questionnaire in order to inform sampled households of the upcoming survey.

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[8] See Appendix A for the original survey (formatted to fit thesis layout).

The first mailing of the questionnaire follows approximately one week later. Reminder postcard is sent approximately one week following the first mailing in order to remind the respondents to fill out and mail back the questionnaire. Upon allowing reasonable amount of time for respondents to respond to the first mailing, the second mailing is sent to all non-respondents from the first mailing. Similarly, the third mailing is sent to all non-respondents from the second mailing, though this time via Priority Mail in order to emphasize the importance of the survey and therefore increase the response rate. Three samples of 1000 households each were selected from the entire United States (*United States sample*), the state of Alaska (*Alaska sample*) and the Alaskan boroughs containing Steller sea lion's critical habitat (*Boroughs sample*). In total, 3000 households were sampled.[9] Each individual was sent a personalized cover letter on university letterhead with an original signature, a questionnaire, a detailed map showing the location of designated critical habitat of the western stock of the Steller sea lion[10] and a pre-paid envelope for sending back the results. The first mailing was mailed out on September 12th, 2000 with a reminder postcard sent one week later. A dollar bill was included with the first mailing as a token of appreciation and to increase the response rate. On November 2nd, 2000 a second mailing of the survey with a new cover letter was sent to non-respondents from the first mailing.

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[9] The services of Survey Sampling, Inc., Fairfield, CT were employed to obtain a representative sample.

[10] See Appendix B for the original map (downscaled to 57% to fit thesis layout).

Later in the winter, non-respondents from the second mailing were sent a third mailing; half by first class mail half by Priority Mail. The survey was constructed to follow recommendations set forth by the NOAA's "blue-ribbon" panel (Arrow et al. 1993) as closely as possible. It began with an introduction of the United States management of the endangered species and its terminology. Respondents were introduced to the Endangered Species Act, to terms "endangered species", "threatened species", "threatened and endangered species list" and "critical habitat". Respondents were also informed of the benefits that threatened and endangered species might provide. Following the introduction, in section one general opinion questions regarding resource extraction, species protection and jobs lost due to species protection were asked in a Likert-scale format[11]. Cummings et al. (1986) refer to this as "researching your preferences", or in other words, collecting your thoughts on the topic. It is important to allow the respondents an opportunity to reflect on the issue, before being asked the specific questions regarding the policy in question. Since prior knowledge on the subject has been shown to be a significant factor influencing respondents' WTP (Giraud et al. 1999), in the same section respondents were also asked to answer "yes" or "no" to whether they have heard or read anything about the endangered Steller sea lion in Alaska, about commercial Pollock fishery in Alaska, and about coastal Alaskan communities.

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[11] Scale ranged from 1 to 5, where 1 was "strongly disagree", 3 was "neutral" and 5 was "strongly agree".

Section two introduced Steller sea lion as an endangered species throughout the western part of its population, talked about possible reasons for the Steller sea lion population decline, and described current Steller sea lion recovery program. Section two also proposed expanded Steller sea lion recovery program and its goal, and talked about possible costs and benefits of the expanded program. Following that information, a dichotomous choice referendum style question, which was used to elicit WTP, was asked. Dichotomous choice referendum style question was formulated as follows:

If the Expanded Federal Steller Sea Lion Recovery Program were the only issue on the next ballot and it would cost your household $___ in additional Federal taxes every year for the next ____ year(s), would you vote in favor of it? (By law the funds could *only* be used for the Steller sea lion program.)

☐YES ☐NO

The bid amounts used in the survey were taken from similar work with endangered species critical habitat protection (Giraud et al. 1999) and were further refined in pre-testing. The payment vehicle was federal taxes. Bid amounts were 1, 3, 5, 10, 25, 50, 75, 100, 200, 350.

In order to investigate temporal elasticity or temporal embedding of WTP estimates and to compare it among the samples, each sample was divided and given three treatments. Treatment one was one-year payment, treatment two was five-year payment and treatment three was fifteen-year payment. Since temporal elasticity of WTP is beyond the scope of this thesis, only the results pertaining to the part of each sample containing treatment one will be presented in the thesis.

Following the referendum question was a certainty question, which was a hundred-point line on which respondents were asked to place a mark to express the level of their certainty in the answer to the referendum question.

Following recommendations for CVM use given by Arrow et al. (1993), respondents were also asked to express their reasons for voting the way they did. Yes and No follow-up questions asked respondents to mark the reasons for voting "yes" as well as the reasons for voting "no". There were eight specific categories plus the ninth category labeled "other" offered in both Yes follow-up and No follow-up questions. Separate categories from Yes and No follow-up questions will be discussed in sections 4.3. and 4.4., respectively.

At the very end of the survey, in section three, socioeconomic questions, such as gender, age, zip code, belonging to conservational or environmental organization, being a fisherman or being related to a fisherman, occupation, education, whether a respondent voted in the last national elections, number of household members and number of household members under 18, as well as last years' household income before taxes, were asked.

After the third mailing, the overall response rate for treatment one was 63.60%. Response rates for *United States*, *Alaska* and *Boroughs samples* were 51.16%, 70.22% and 68.93% respectively.

4. RESULTS

4.1. Prior Knowledge

Table 1 shows percentages of respondents who answered "yes" to the questions about their prior knowledge on Steller sea lion, commercial Pollock fisheries in Alaska and Alaskan coastal communities questions. Most of the respondents from *Boroughs* and *Alaska samples* indicated prior knowledge of the Steller sea lion, commercial Pollock fisheries and coastal Alaskan communities as opposed to *United States sample*, where less then a third of respondents had prior knowledge on these three issues.

Table 1 Prior Knowledge

	Percentage of "yes" responses to knowledge questions		
	Boroughs Sample	*Alaska Sample*	*United States Sample*
Have you read or heard anything about the endangered Steller sea lion in Alaska?	88.0%	77.5%	23.0%
Have you read or heard anything about the commercial Pollock fishery in Alaska?	87.1%	80.2%	12.9%
Have you read or heard anything of the Alaskan coastal villages in the Pacific, Bering Sea or Gulf of Alaska?	92.8%	85.0%	31.7%

4.2. Referendum Question Votes

In total, 46.28% of the respondents voted "yes" and 53.72% voted "no" to the dichotomous choice referendum question across all ten bid-amounts. More then 60% of the boroughs respondents voted "no" and more then 50% of the Alaskan respondents voted "no" to the referendum question. Less then 45% of the United States respondents voted "no" to the referendum question. Summary of the percentages of respondents voting "yes" and "no" across geographically nested samples and for all three samples together are given in Table 2.

Table 2 Referendum Question Votes

	Percentage of **"yes"** responses to the referendum question	Percentage of **"no"** responses to the referendum question
All three samples	46.28%	53.72%
Boroughs Sample	39.71%	60.29%
Alaska Sample	46.32%	53.68%
United States Sample	55.26%	44.74%

4.3. Voting "Yes" to the Referendum Question

Categories in Yes follow-up question included reasons such as contributing to a good cause (variable *YesCause*), having duty to do his/her share (variable *YesDuty*), being concerned about other people not supporting the program (variable *YesSupport*), being concerned about environmental quality in general (variable *YesEnv*), enjoying watching Steller sea lion in the wild (variable *YesWatch*), getting pleasure from knowing that Steller sea lion exists in Alaska (variable *YesExist*), wanting an option to see wild Steller sea lion in the future (variable *YesOption*), and wishing to protect Steller sea lion for future generations (variable *YesFuture*).[12] These reasons represent motives respondents have for being willing to pay for the expanded Steller sea lion recovery program. They may also be viewed as different values respondents hold for the program. As such, variables *YesCause*, *YesDuty*, *YesSupport* and *YesEnv* might represent "warm glow" value, *YesExist* might represent existence value, *YesOption* might represent option value, *YesFuture* might represent bequest value, and *YesWatch* might represent use-value. Due to respondents checking several categories simultaneously, data from the Yes follow-up question could not be used to identify separate categories of the non-use value nor could they be used to extract the "warm glow" values.

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[12] For exact wording of the Yes follow-up question, please refer to the Appendix A.

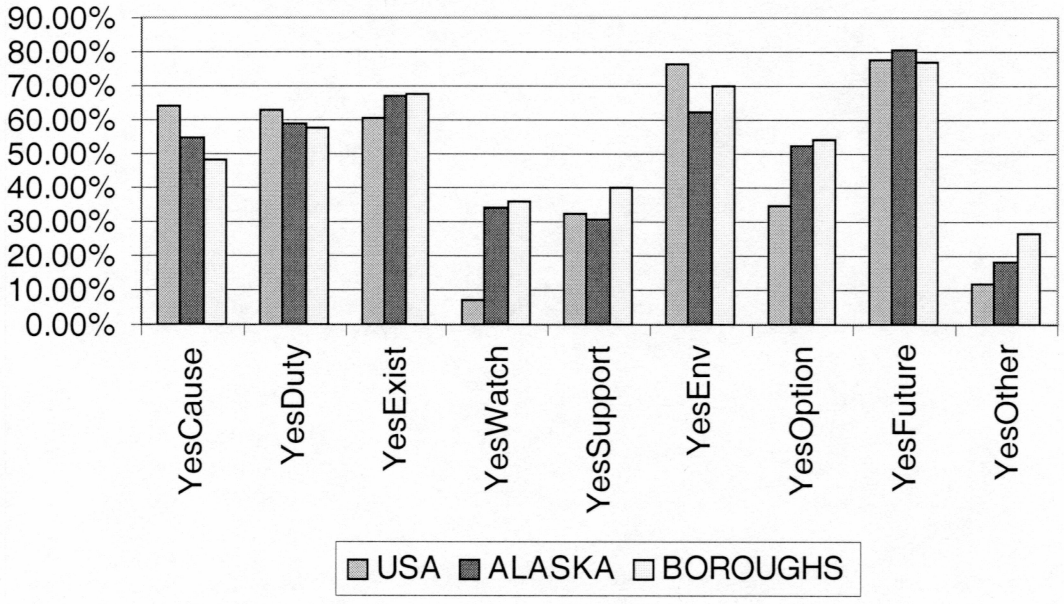

Figure 6 Reasons for Voting "Yes" to the Referendum Question

Figure 6 shows percentages of respondents across geographically nested samples choosing different reasons for voting "yes" to the referendum question. It appears that respondents might in general be much more concerned with global environmental issues then they are concerned with the destiny of the Alaskan Steller sea lion and its recovery program per se. Moreover, a very high percentage of the respondents chose *YesFuture* as their reason for voting "yes", which might be an indication of a concern that people's present misbehavior towards environment might lead to inability of future generations to see Steller sea lion in the wild.

Reasons such as *YesCause* and *YesDuty* were chosen by a significant number of respondents from all three samples, indicating again some other value (probably "warm glow") and not the expanded Steller sea lion recovery program per se as a driving force for voting "yes". Percentages of respondents choosing *YesCause* and *YesDuty* appear to be decreasing from the *United States* to *Alaska* to *Boroughs sample* indicating that "warm glow" values might be of the most importance to the United States respondents and of the least importance to the boroughs respondents. Note also a very low percentage of the United States respondents choosing *YesWatch*, correctly reflecting inability of the United States respondents to experience use-value as they live so far away from the resource and the policy measures in question.

4.4. Voting "No" to the Referendum Question

A No follow-up question was asked in order to determine if those refusing to pay reflect valid representation of their value or a protest about some feature of the simulated market (scenario rejection responses). If a respondent chose to vote "no" due to protest reasons, her/his vote would be considered a protest vote. If respondent voted "no" due to non-protest reasons, her/his vote would indicate valid representation of her/his value. Categories in the No follow-up question included reasons such as being against paying for more governmental programs (variable *NoGov* - protest), and being unfair to expect the respondent to pay for the program (variable *NoUnfair* - protest).

Categories in the No follow-up question also included reasons such as being against additional fishing restrictions in the area (variable *NoRestrict* - non-protest/possible protest), considering decrease in economic likelihood of the Alaskan coastal communities due to fishing restrictions to be too large (variable *NoVillage* - non-protest/possible protest), believing that the program will not help to preserve the species (variable *NoHelp* - non-protest/possible protest), expanded Steller sea lion not being worth that specific amount of money to the respondent (variable *NoWorth* - non-protest), respondent would be willing to pay less then the specified amount (variable *NoWTP* – non-protest), and considering the length of payment to be too long (variable *NoLong* - non-protest). [13]

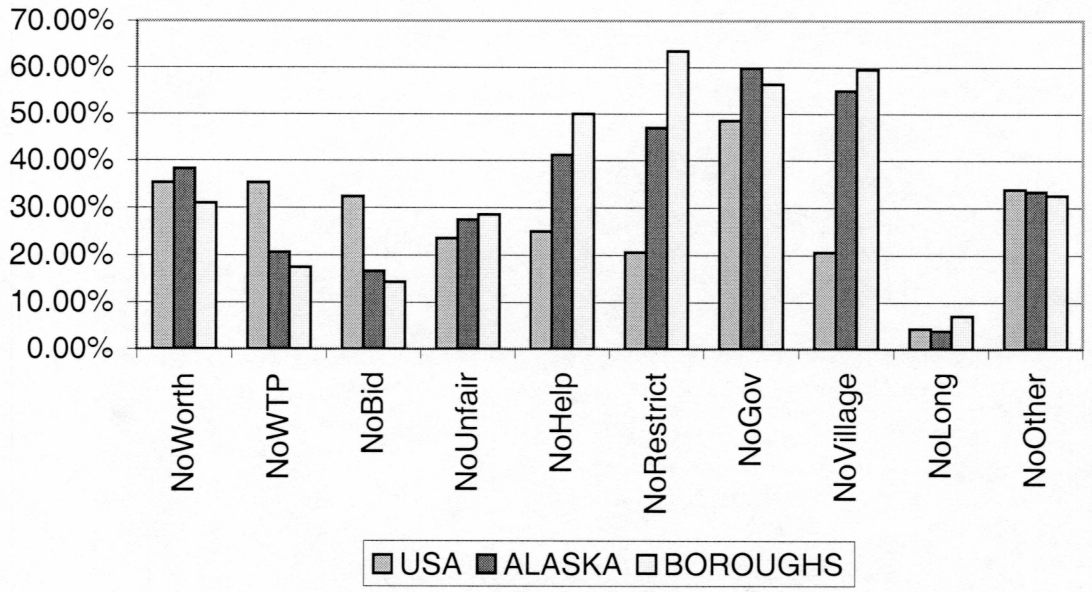

Figure 7 Reasons for Voting "No" to the Referendum Question

[13] For exact wording of the No follow-up question, please refer to the Appendix A.

Figure 7 shows percentages of respondents across geographically nested samples choosing different reasons for voting "no" to the referendum question. A large proportion of respondents from all three samples chose *NoGov* as their reason for voting "no", which would joined with other protest and possible protest votes, sum up to more then 50% of the votes representing protest votes. Note that a very high percentages of boroughs respondents chose *NoRestrict, NoVillage and No Help* as their reasons for voting "no", reflecting their disapproval (possible protest votes) with the expanded Steller sea lion recovery program. Percentage of the respondents choosing those three reasons for voting "no" decreases from *Boroughs* to *Alaska* to *United States sample*, which is probably a reflection of decreasing knowledge of the program and decreasing direct influence of the policy measures from *Boroughs* to *Alaska* to *United States sample*. Some of the respondents from *Alaska* and *United States samples* may not be protesting when choosing one or all of those three categories as their reasons for voting "no". Protest votes are often not considered valid representations of the individual willingness to pay, though they do represent valid concerns. These concerns may include a rejection of the basic premise of the CVM market, some feature of the scenario, incorporating the costs of the program, other concerns about the survey or generalized concerns about the overall issue. Following common practice of CVM studies involving endangered species programs (Giraud et al. 1999), and based on the assumption that valuable information may be lost if data are thrown out of the analysis, both protest responses and possible protest votes were used, together with non-protest votes, in logistic regression and WTP estimation.

Percentage of the respondents validly representing their values through their votes (those choosing non-protest reasons) totaled 42.7%.

4.5. Logistic Regression

If vector X = *[Bid, ProSpecies, ProJobs, KnowPollock],* where *Bid* represents price (*$A*) that respondent can pay in federal taxes for the public good *G*, *ProSpecies* represents respondent's general opinion on species protection, *ProJobs* represents respondent's general opinion on lost jobs due to species protection and *KnowPollock* represents respondent's knowledge on Pollock fishery in Alaska, then

$$P_n(i) = \frac{1}{1+\exp^{-(\beta_1+\beta_2(Bid_n)+\beta_3(\Pr oSpecies_n)+\beta_4(\Pr oJobs_n)+\beta_5(KnowPollock_n))}} \qquad (18)$$

Following maximum likelihood estimation of the binary logistic model (9) – (14), vector of parameters $B = [\beta_1, \beta_2, \beta_3, \beta_4, \beta_5]$ was estimated. Parameter estimates together with their z-statistics are shown in Table 3.

The McFadden R^2 was used as a measure of the model's goodness of fit. The McFadden R^2 is $1 - LL_m/LL_0$, where LL_m is the value of the log likelihood function from the model evaluated at the parameter values that maximize the log likelihood function, and LL_0 is the value of the log likelihood function when all of the slope coefficients are set equal to zero. The McFadden R^2 is bounded between zero and one, with values closer to one representing the better fit.

Another goodness of fit measure used was the likelihood ratio statistics, which is tested using a χ^2 distribution. Null hypothesis that all coefficients are equal to zero is rejected, if the calculated likelihood ratio statistics $-2(LL_0 - LL_m)$ is greater then critical $\chi^2(df)$.

Table 3 Logistic Regression Results[14]

Variable	**United States Sample**		**Alaska Sample**		**Boroughs Sample**	
	Coefficient estimate[15]	z-statistic	Coefficient estimate	z-statistic	Coefficient estimate	z-statistic
Constant	-2.615	-1.352	-2.148	-1.464	0.187	0.143
Bid	-0.008*	-3.436	-0.005†	-2.327	-0.002	-1.347
ProSpecies	1.405*	3.847	1.180*	4.736	0.974*	4.094
ProJobs	-0.765*	-2.507	-0.585*	-2.659	-0.957*	-4.402
KnowPollock	1.696*	2.063	0.065	0.127	-1.247†	-2.250
Number of observations	137		168		208	
LL_m	-58.087		-76.994		-93.791	
LL_0	-94.138		-116.401		-139.485	
McFadden R^2	0.383		0.339		0.326	
Likelihood ratio statistic (4 df)	72.103		78.815		91.390	

[14] The analysis was performed using software Limdep. Vers. 7.0. (1999). Plainview, NY: Econometric Software, and re-checked with SAS. Vers. 8.0. (1999). Cary, NC: SAS Institute, Inc., and Eviews. Vers. 3.1. (1998). Irvine, CA: Quantitative Micro Software.

[15] Coefficients assigned * were significant at $\alpha < 0.01$, coefficients assigned † were significant at $\alpha < 0.05$, other coefficients were significant at $\alpha > 0.05$.

Table 3 shows that, for all three geographically nested samples, holding everything else constant, the probability of paying *$A* for the expanded Steller sea lion recovery program increases as *$A* (*Bid*) decreases ($\beta_2 < 0$). Coefficient β_2 for the *Boroughs sample* is not significantly different then zero, it is significantly different then zero at $\alpha_{.05}$ for the *Alaska sample*, and it is significantly different then zero at $\alpha_{.01}$ for the *United States sample*. It also increases in magnitude from *Boroughs* to *Alaska* to *United States sample*. Respondents from the Alaskan boroughs, which contain Steller sea lion's critical habitat, are, thus, not sensitive to the price when expressing their WTP for the expanded Steller sea lion recovery program, whereas respondents from the entire United States are more sensitive to the price then are the respondents from the entire state of Alaska.

The probability of paying *$A* for the expanded Steller sea lion recovery program increases as respondents' agreement with species protection (*ProSpecies*) increases ($\beta_3 > 0$) and it decreases as respondents' agreement with jobs protection (*ProJobs*) increases ($\beta_4 < 0$), for all three samples. Sign of the β_5 (*KnowPollock*), however, does not equal across all three samples. Coefficient $\beta_5 < 0$ for *Boroughs sample*, which indicates that the more knowledge respondents from the boroughs have about the Pollock fishery in Alaska, the less likely they are to pay for the expanded Steller sea lion recovery program. On the other hand, $\beta_5 > 0$ for *Alaska sample* and *United States sample*, which indicates that more knowledge respondents from Alaska and from USA have about the Pollock fishery in Alaska, the more likely they are to pay for the recovery program.

β_5 for *Alaska sample* is not significantly different then zero. All signs of the coefficients correspond to the findings of Giraud et al. (1999), except for the sign of the variable *KnowPollock* for *Boroughs sample*. One possible explanation for the observed difference in signs of β_5 between the *Boroughs* and *United States samples* is the difference in the scope of knowledge that respondents from boroughs and the United States have on the Pollock fishery in Alaska. Knowledge acquired by the respondents from the *Boroughs sample* probably comes mostly from being in close touch, either themselves or through family and friends, with the actual fishing restrictions. Thus, being the bearers of the direct costs, their willingness-to-pay for the expanded Steller sea lion recovery program decreases with their knowledge on the Pollock fishery in Alaska. On the other hand, it might be safe to state that the United States respondents in general are not experiencing the direct costs of the fishing restrictions in Alaska. Their knowledge on Pollock fishery might instead be completely different. If they perceive expanded Steller sea lion recovery program as beneficial public good and have limited knowledge on Pollock fishery in Alaska, with an emphasis on its negative impacts on the ecosystem, they most probably would be willing to pay more for the expanded Steller sea lion recovery program as their knowledge on the Pollock fishery in Alaska increases.

4.6. Willingness-to-Pay for the Expanded Steller Sea Lion Recovery Program

Applying (16) and (17) to (18), unrestricted and restricted mean WTP estimates for *Boroughs, Alaska* and *United States samples* were estimated as follows:

$$\textit{unrestricted mean } WTP = \frac{\beta_1 + \beta_3 \bar{x}_3 + \beta_4 \bar{x}_4 + \beta_5 \bar{x}_5}{|\beta_2|} \qquad (19)$$

$$\textit{restricted mean } WTP = \frac{1}{|\beta_2|} \ln\left(1 + e^{\beta_1 + \beta_3 \bar{x}_3 + \beta_4 \bar{x}_4 + \beta_5 \bar{x}_5}\right) \qquad (20)$$

where $\bar{x}_3, \bar{x}_4, \bar{x}_5$ are mean values of variables *ProSpecies*, *ProJobs* and *KnowPollock* respectively, β_1 is the estimated coefficient on the constant, β_2 is the estimated coefficient on the variable *Bid*, and $\beta_3, \beta_4, \beta_5$ are estimated coefficients for *ProSpecies*, *ProJobs* and *KnowPollock* respectively.

Estimated mean WTP estimates, unrestricted and restricted, together with their 95% confidence intervals (CI) for all three geographically nested samples are shown in Table 4.[16]

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[16] Estimates were obtained using Gauss for Windows NT. Vers. 3.2.19. (1996). Maple Valley, WA: Aptech Systems, Inc. Dr. Mark Herrmann has kindly provided his code. Please see Appendix C for the code used.

Table 4 Willingness-to-Pay across Geographically Nested Samples

	United States Sample	**Alaska Sample**	**Boroughs Sample**
Unrestricted mean WTP	$121.82	$56.46	$-240.34
95% confidence interval of mean WTP	[$66.17, $210.46]	[$-123.02, $167.96]	[$-5094.00, $-27.92]
Restricted mean WTP	$158.79	$171.98	$179.86
95% confidence interval of mean WTP	[$112.39, $305.39]	[$102.92, $747.98]	[$81.90, $2649.98]

For each sample the null hypothesis is that unrestricted mean WTP estimate equals to or is less then zero, as opposed to the alternative that unrestricted mean WTP estimate is greater then zero. Rejecting the null hypothesis would mean that expanded Steller sea lion recovery program has positive economic value and should be included when calculating the national benefits of the endangered species management programs.

Confidence intervals around mean WTP estimates at the 95% confidence level were calculated using method developed by Park et al. (1991), which is built upon the Krinsky and Robb method (1986). If the confidence intervals are negative or do not include zero, WTP for the expanded recovery program for the Steller sea lion has positive economic value.

Unrestricted mean WTP for the *United States sample* is $121.82, for *Alaska sample* it is $56.46 and for *Boroughs sample* it is $-240.34. Restricted mean WTP for *United States sample* is $158.79, for *Alaska sample* restricted mean WTP is $171.98 and for *Boroughs sample* restricted mean WTP is $179.86.

Confidence intervals around unrestricted mean WTP estimates for *Alaska* and *Boroughs samples* include zero, meaning that null hypotheses for those two samples failed to be rejected at the 95% confidence level. WTP for the expanded recovery program for the Steller sea lion, therefore, would not have positive economic value for the *Alaska* and *Boroughs samples*. Confidence interval around unrestricted mean WTP estimate for the *United States sample* does not include zero meaning that the null hypothesis is rejected and that WTP for the expanded recovery program for the Steller sea lion has positive economic value for *United States sample*.

Such differences between the three samples might indicate that problems can occur in policy-decision making situations when, for instance, results of a CV study performed only on a national basis are used to make decisions regionally and vice versa.

By further examining unrestricted mean WTP estimates we might conclude that WTP increases from *Boroughs* to *Alaska* to the *United States sample,* which are also regions most to least affected by the policy change.

This result would indicate positive relationship between WTP estimates and geographically nested samples, which is in opposition with results on relationship between WTP estimates and geographical distance from the resource, established by studies of Sutherland and Walsh (1985) and Pate and Loomis (1997). This may not be surprising a result, however, if we consider differences between the policies and resources investigated in these studies. Water or wetlands resources and their quality improvement might be considered more valuable to people living closer to these resources, than might be Steller sea lion and its population recovery for people living in the Alaskan boroughs that contain Steller sea lion's critical habitat. Furthermore, the Steller sea lion case in Alaska is characterized by the strong outcome uncertainty of the Steller sea lion recovery policy and lack of knowledge on which policy measures should be implemented, which was not the case in the above-mentioned studies. Such circumstances would, also, explain why the expanded Steller sea lion recovery program might be less desirable for the people who know more about the policy (i.e. *Boroughs sample*) than for the people who know less about the policy (i.e. *United States sample*). The coefficients on *KnowPollock* variable would be in accordance with that notion.

When restricted, WTP distribution shifts to the positive region, forcing mean WTP estimates to increase. Mean WTP estimate for *Boroughs sample* increased from $-240.34 to $179.86, for *Alaska sample* it increased from $56.46 to $171.98 and for the *United States sample* it increased from $121.82 to $158.79.

Furthermore, when WTP is restricted to the non-negative region mean WTP estimates are similar for all three geographically nested samples. In order to test, however, if there is a statistically significant difference between restricted mean WTP estimates across geographically nested samples method of convolutions needs to be applied to these data.

A question remains whether or not negative WTP estimates have a valuable interpretation or whether WTP should be restricted to the positive region and if so, what is the interpretation for restricted mean WTP estimate. This is a source of controversy. Is negative WTP estimate a consequence of statistical fit or does it represent economic harm? Do respondents actually want to be compensated for the policy? The probability of the respondents voting "yes" is low, even for the smaller bid amounts. The functional form might, thus, be forced to extrapolate into the negative region. On the other hand, people from the boroughs already are experiencing costs of the current policy's fishing restrictions and those costs would only be increased with the expanded recovery program. Some people from the boroughs might, thus, be against the expanded program even if it were free. They may in effect be including their personal costs when contemplating WTP for the policy. Thus, obtaining negative WTP estimate would in this case seem justified, although using the negative WTP estimates might result in double counting costs in a benefit-cost analysis.

5. CONCLUSION

During Summer 2000 CVM study was conducted in order to obtain Willingness-to-Pay (WTP) estimates for the expanded Steller sea lion recovery program across geographically nested samples and also to determine whether WTP estimates differed across geographically nested samples (borough, state and national levels). This geographical nesting separates out areas, which are affected differently by the policy change. One of the measures of the expanded Steller sea lion recovery program is increasing restrictions on fish harvesting in the Steller sea lion's designated critical habitat. Obtained WTP estimates may be useful in future decision-making processes on policies regarding Steller sea lion recovery program.

When making policy decisions in regard to endangered species, it is often useful to use WTP estimates of the United States. Sometimes, however, it is important to obtain WTP estimates of the regions most affected by the potential policy change. This study estimates WTP for the expanded Steller sea lion recovery program for the United States, the state of Alaska and Alaskan boroughs containing Steller sea lion's designated critical habitat. The United States is the least affected and the boroughs are the most affected by the policy change. For the purpose of the study three samples of 1000 people each were randomly selected from the United States, the state of Alaska and the Alaskan boroughs containing Steller sea lion's designated critical habitat.

Following maximum likelihood estimation of the binary logistic model, parameter estimates on significant variables in the model were estimated for each of the three geographically nested samples. Hanemann's formulas (Hanemann 1989) for unrestricted and restricted WTP estimates were used to estimate WTP for each sample. When unrestricted, WTP is an area under the cumulative distribution function of individual's true maximum WTP and above the x-axis (i.e. it represents compensating variation when price equals zero). When restricted, the area in the limits between minus infinity and zero is subtracted from the total area of the unrestricted WTP.

For each sample null hypothesis is that unrestricted mean WTP estimate equals to or is less then zero, as opposed to the alternative that unrestricted mean WTP estimate is greater then zero. Rejecting the null hypothesis would mean that expanded Steller sea lion recovery program has positive economic value and should be included when calculating the national benefits of the endangered species management programs. Confidence intervals around mean WTP estimates at the 95% confidence level were calculated using method developed by Park et al. (1991), which is built upon the Krinsky and Robb method (1986). If the confidence intervals are negative or do not include zero, WTP for the expanded recovery program for the Steller sea lion has positive economic value.

Unrestricted mean WTP for the *United States sample* is $121.82, for *Alaska sample* it is $56.46 and for *Boroughs sample* it is $-240.34.

Confidence intervals around unrestricted mean WTP estimates for *Alaska* and *Boroughs samples* include zero, and confidence interval around unrestricted mean WTP for the *United States sample* does not include zero. The null hypotheses fail to be rejected for *Boroughs* and *Alaska samples* while it is rejected for the *United States sample* at the 95% confidence level. WTP for the expanded recovery program for the Steller sea lion, therefore, would not have positive economic value for *Alaska* and *Boroughs samples*, but it would have positive economic value for the *United States sample*.

When restricted, WTP distribution shifts to the positive region, forcing mean WTP estimates to increase. Restricted mean WTP for *United States sample* is $158.79, for *Alaska sample* restricted mean WTP is $171.98 and for *Boroughs sample* restricted mean WTP is $179.86.

Restricted and unrestricted mean WTP estimation techniques can lead to dramatically different estimates in terms of policy recommendations. Since unrestricted and restricted mean WTP estimates for the *United States sample* are the most stable, the United States WTP might be the most representative for the value of the expanded Steller sea lion recovery program.

The unrestricted model also suggests positive relationship between WTP estimates and geographically nested samples, which are regions most to least affected by the policy change.

Such differences between the three samples might indicate that problems can occur in policy-decision making situations when, for instance, results of a CV study performed only on a national basis are used to make decisions regionally and vice versa. Forcing WTP to fall in the non-negative region leads to similar estimates of mean WTP. In order to test, however, if there is a statistically significant difference between restricted mean WTP estimates across geographically nested samples method of convolutions needs to be applied to these data.

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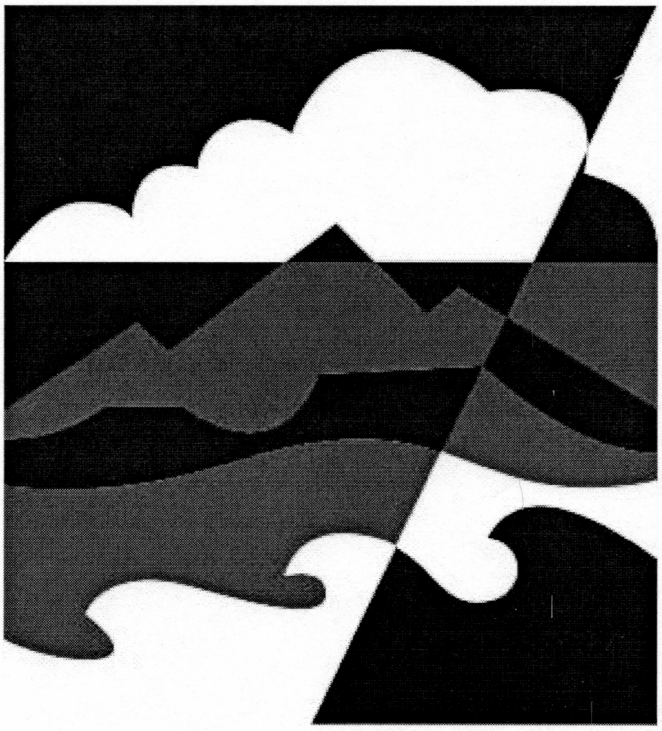
7. APPENDICES

Appendix A – Contingent Valuation Method Survey
(formatted to fit thesis layout)

Expanding Endangered Species Recovery Programs...



What do you think?

UNIVERSITY OF ALASKA
FAIRBANKS

Department of Economics
P.O. Box 756080
Fairbanks, AK 99775-6080

Management of Endangered Species in the United States

The management of endangered species in the United States is a much debated topic these days. Your views on this topic are an important part of this debate. Policy makers want your opinions in order to make the best policy decisions. Before you answer, we would like to clarify a few items.

The Federal Endangered Species Act requires protection for threatened and endangered species, including over 65 mammals, 90 birds, 101 fish, 168 "other species" (such as salamanders, spiders, butterflies, turtles and snails), and 468 plants. Preventing extinction often requires preserving the habitat necessary for survival.

The reasons why wildlife species become threatened or endangered are often not fully known. The programs used to help species recover may not guarantee their recovery. Nevertheless, federal law requires that such programs be put in place when they are expected to be reasonable and prudent.

In this survey, we use the following terms:

Endangered Species – a federally listed species that is in danger of extinction within the foreseeable future on a significant portion of its habitat.

Threatened Species – a federally listed species that is likely to become endangered within the foreseeable future on a significant portion of its habitat.

Threatened and Endangered Species List – the list of species which are designated by the federal government as Threatened or Endangered.

Critical Habitat – land or waters designated by the federal government as crucial for the survival or recovery of the species. Usually some human activity is restricted on these units. For instance, in coastal waters, fishing may be restricted.

What benefits might threatened and endangered species provide?

While it is difficult to identify the benefit of each individual threatened or endangered species, as a group they provide the following benefits to humans:

1. Indicators of the health of the environment where people live. Many species are more sensitive to pollution than people, so species often serve as an early warning system for rising pollution;

2. Sources of medicines and substances for commercial use;

3. Stabilizers that maintain a balance among predators and prey so as not to have population explosions of one species or pest; and

4. Protecting diversity of species and their unique genetic information, which may have value that we currently don't realize.

SECTION I – Your Views on Endangered Species Management

People often have different views about environmental and economic issues.
Please, indicate your view by CIRCLING ONE NUMBER FOR EACH STATEMENT.
Note that 1 = strongly disagree and 5 = strongly agree.

	STRONGLY DISAGREE		NEUTRAL		STRONGLY AGREE	DON'T KNOW
If managed carefully, commercial fishing vessels should be allowed to harvest fish and shellfish from oceans and seas	1	2	3	4	5	0
If human activities are found to harm a wildlife species, we should work to protect that species from extinction; even if it does not appear important to human well being	1	2	3	4	5	0
There are already too many government programs designed to protect wildlife and fish	1	2	3	4	5	0
If jobs are lost due to endangered species management, the cost of protecting the species is too high	1	2	3	4	5	0
I am glad that threatened or endangered species are protected even if I never see them	1	2	3	4	5	0
Protection of threatened and endangered species is a responsibility I am willing to pay for	1	2	3	4	5	0

Please circle the best answer for each question

1. Have you eaten white fish in the last 12 months? (White fish includes fish sticks, imitation crab, fish patties, etc.)
   Yes No

2. Have you read or heard anything about the endangered Steller sea lion in Alaska?
   Yes No

3. Have you read or heard anything about the commercial Pollock fishery in Alaska?
   Yes No

4. Have you read or heard anything of the Alaskan coastal villages in the Pacific, Bering Sea or Gulf of Alaska?
   Yes No

SECTION II – Steller Sea Lion: An Endangered Species

WHAT IS THE PROBLEM?

The western population of the Steller sea lion has been federally listed as an endangered species. It is continuing to decline in spite of current recovery efforts.

Biologists are still learning why the Steller sea lion has declined; there may be many reasons:

- A general warming of ocean temperatures, which changed the types of food sources in some areas;
- Increased commercial fishing activity in the North Pacific, Gulf of Alaska and Bering Sea, which is critical habitat for the Steller sea lion (See map);
- Orcas or "Killer Whales" are eating more Steller sea lions than they used to;
- Competition with other animals, that may eat the same food as the Steller sea lions; and
- An increase in natural toxins in the waters.

CURRENT STATUS OF THE FEDERAL STELLER SEA LION RECOVERY PROGRAM

- The critical haulouts and rookeries have been identified (these are the rocks and beaches used by the Steller sea lions to breed, raise their young and rest);
- A 10 to 20-mile buffer zone around each of these areas, as well as three foraging areas have been designated as protected critical habitat (please, refer to the map for the critical habitat);
- Commercial Pollock trawl-fishing has been banned from these areas in order to improve food sources and reduce human conflicts with Steller sea lions (Pollock is one of the most commonly harvested fish in the United States and is a major export good);
- Federal agencies are conducting research to understand the habitat needs of the Steller sea lion and the reasons for their declining population;
- In spite of this effort, the western population of Steller sea lion is still declining.

THE PROPOSED *EXPANDED* FEDERAL STELLER SEA LION RECOVERY PROGRAM

In addition to the above current program, the Expanded Program would benefit Steller sea lions by;

- Restricting commercial harvesting of 3 more species in the critical habitat (mackerel, Pacific cod, and herring) in order to minimize human interaction and leave these fish as food for the Steller sea lion;
- Doubling the funding for research to better understand Steller sea lion habitat needs and reasons for the decline of the Steller sea lion.

What are some possible costs of the proposed expanded Steller sea lion recovery program?

- Commercial fishing operators would experience increasing costs due to commercial fishing restrictions on more fisheries including mackerel, Pacific cod and herring in the North Pacific, Gulf of Alaska and the Bering Sea;
- Some coastal Alaskan communities would no longer be able to support themselves because commercial fishing is their main source of income. This may lead to some people moving away and to some loss of local tax revenue;
- More scientists would be hired to study habitat needs and monitor Steller sea lion populations.

What are some possible benefits of the proposed expanded Steller sea lion recovery program?

- A better understanding of the habitat needs and reasons for the decline of the Steller sea lion;
- Less human interaction in the critical habitat;
- More availability of the food that the Steller sea lions eat in their critical habitat.

The Steller sea lion recovery program is managed by National Marine Fisheries Service.
They maintain a web page with more information on the recovery efforts. You may read more by going to:
http://www.fakr.noaa.gov/protectedresources/stellers.htm
If you have visited this web page, did you find it useful? □YES □NO

The goal of the Proposed Expanded Federal Steller Sea Lion Recovery Program is to increase the population of Steller sea lion to the point where it would no longer be listed under the Endangered Species Act (i. e. neither listed as threatened or endangered).

YOUR CHANCE TO VOTE

If a majority of households in the U.S. vote to **approve** the proposed expanded Steller sea lion recovery program, the money would go into a fund that could legally be used only for this program.

If a majority of households in the U.S. vote to **not approve** the proposed expanded Steller sea lion recovery program, the limited current program would continue.

Policy makers want to know how YOU would vote...

If the Expanded Federal Steller Sea Lion Recovery Program were the only issue on the next ballot and it would cost your household $____ in additional Federal taxes every year for the next ___ year(s), would you vote in favor of it?
(By law the funds could *only* be used for the Steller Sea Lion Program.)

YES NO

How certain are you of your answer to the previous question?
Please place an **X** on the line below to indicate your level of certainty:

not certain< ----------|---------- >very certain

IF YOU VOTED NO on the last page, please tell us why.
We are interested in the reason(s) you voted NO. Please check all that apply:

____ The expanded Steller sea lion program is not worth this much money to me.

____ I am not willing to pay this amount, but I would be willing to pay $____. (fill in a dollar amount).

____ It is unfair to expect me to pay for the expanded Steller sea lion program.

____ I believe that the expanded Steller sea lion program will not help preserve this species.

____ I do not want additional restrictions placed on commercial fishing in this area.

____ I am opposed to paying for more government programs.

____ The loss to the coastal Alaskan communities and their economic livelihood is too large.

____ The length of payment is too long.

____ Other, please explain:_____

IF YOU VOTED YES on the last page, please tell us why.
We are interested in the reason(s) you voted YES. Please check all that apply:

____ I would get pleasure from knowing that I had contributed to a good cause.

____ I would pay because I have a duty to do my share to protect wildlife.

____ I would get pleasure from knowing that Steller sea lions will continue to exists in Western Alaska.

____ I enjoy watching Steller sea lions in the wild.

____ I am concerned that other people may not support this program.

____ I am concerned about environmental quality in general.

____ I want the option to see wild Steller sea lions in the future.

____ I wish to protect this species for future generations.

____ Other, please explain:_____

SECTION III – About you

These last few questions will help us to see how well this study represents the characteristics of general population. The following questions are used to match our sample responses to US Census Bureau data. Your answers are strictly confidential and will only be used for the scientific research of this study.
You will not be identified in any way.

1. Are you: _____ Male _____ Female

2. What is your age: _____ Years

3. What is your zip code? _____

4. How long have you lived in your current state of residence? _____ Year(s)

5. Are you a member of a conservation or environmental organization? Yes No

6. Including yourself, has anyone in your household ever worked (even part time) in commercial fishing?

Yes No

7. What is your occupation? _____

8. Did you vote in the last national election? Yes No

9. Number of years of finished formal schooling? (Please, circle one)

1 2 3 4 5 6	7 8 9	10 11 12	13 14 15 16	17 18 19 20 21+
(Elementary)	(Jr. High)	(High School)	(College or Technical School)	(Graduate or Professional School)

12. How many members are in your household? _____ Person(s)

How many members of your household are under 18? _____Person(s)

13. Including yourself, what was your approximate total *household* income from all sources (before taxes) last year?

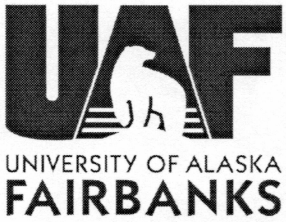
____ less than $ 10,000
____ $ 10,000 to $ 20,000
____ $ 20,001 to $ 30,000
____ $ 30,001 to $ 40,000
____ $ 40,001 to $ 50,000
____ $ 50,001 to $ 60,000
____ $ 60,001 to $ 70,000
____ $ 70,001 to $ 80,000
____ $ 80,001 to $ 90,000
____ $ 90,001 to $ 100,000
____ $100,001 to $ 150,000
____ over $ 150,000

Thank You for Completing the Survey!

If you have any additional thoughts on endangered species or critical habitat management, please feel free to write them down in the space provided below. When you are finished, please mail the survey in the enclosed stamped return envelope.

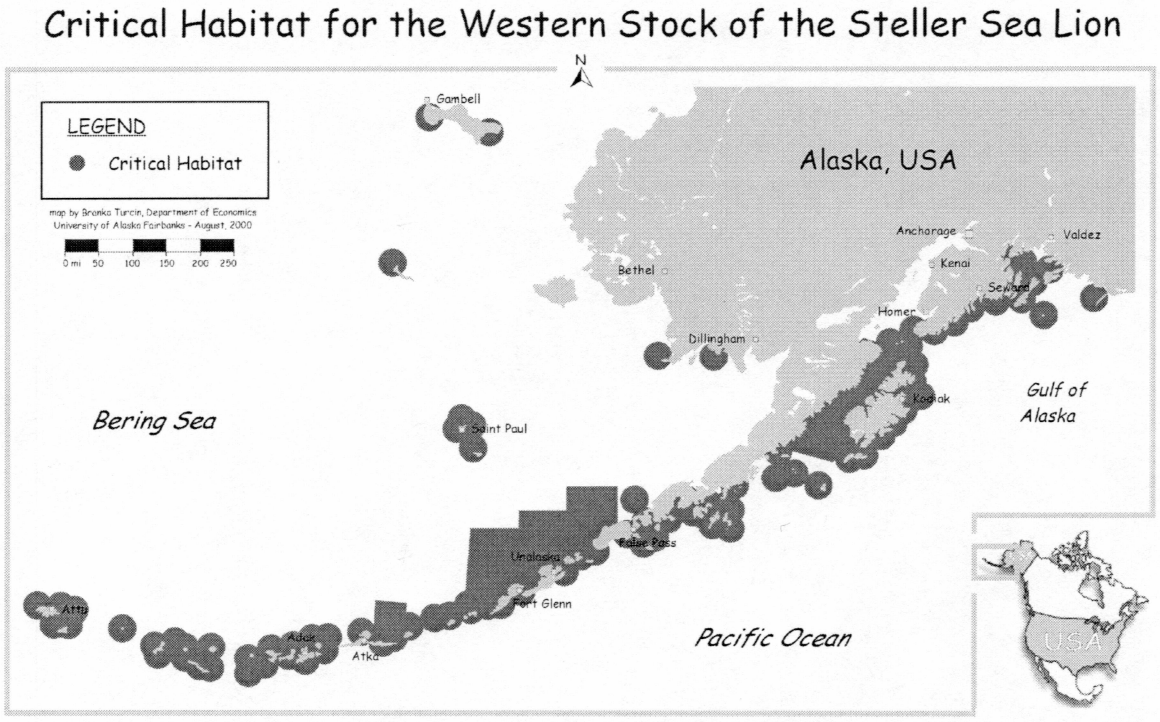
fold here----------

fold here----------



Department of Economics
P.O. Box 756080
Fairbanks, AK 99775-6080

Appendix B – Map of Designated Critical Habitat for the Western Stock of the Steller Sea Lion



Note: In order to fit thesis layout map was downscaled to 57% of the original map size. Original height of the map was 6.51'' and original width of the map was 10.53''. Layout of the original map was landscape.

Appendix C – Gauss Code

```
new;
cls;
output file = Branka1.out reset;
/*WTP and CI Estimates for Branka's Logit Model*/
/*Set up for bootstrap confidence interval paramers*/
let draws = 10000;
c90={500,9500};
c95={250,9750};
c99={50,9950};
/*** Modes Burough=1, Alaska = 2, USA = 3****/
print "For Borough type 1, for Alaska 2, for USA 3";
mode=con(1,1);
if mode ==1;
title = "Borough";
/*******  Borough  (1) *******/
beta1 = {0.187400, -0.002453, 0.974327, -0.956578, -1.247332} ;
/****Enter Beta Hats including price****/
mean1 = {1, 0, 3.516827, 3.259615, 0.870192} ;
/**Enter Means in order of Beta Hats, for WTP PUT IN ZERO FOR PRICE ****/
```

```
vcov1 = {
1.720744711520   -.000044802535   -.234001585782   -.190504720539   -
.253361779354,
-.000044802535   0.000003318910   -.000048134798   0.000017425247   -
.000078675174,
-.234001585782   -.000048134798   0.056644710574   0.010213558934   -
.010985757115,
-.190504720539   0.000017425247   0.010213558934   0.047225703490
0.010765369733,
-.253361779354   -.000078675174   -.010985757115   0.010765369733
0.307276986979
} ;  /****Enter Variance-Covariance Matrix By Row****/
elseif mode ==2;
title = "Alaska";
/*******  Alaska  (2) *******/

beta1 = { -2.148432, -0.004888, 1.17984, -0.585116, 0.064729} ;
/****Enter Beta Hats including price****/
mean1 = {1, 0, 3.556548, 3.11756, 0.809524} ;
/**Enter Means in order of Beta Hats, for WTP PUT IN ZERO FOR PRICE ****/
vcov1 = {2.15457032531       -0.000493730874795          -0.300393231007
.22451530724                 -0.348015354189,
```

```
-0.00049373087479        4.41124396456e-06        -9.51005047428e-
063.43507888533e-05      0.000134768599472,
-0.300393231007          -9.51005047428e-06       0.0620680450746
0.0166603124837          0.0281785227667,
-0.22451530724           3.43507888533e-05        0.0166603124837
0.0484299254902          0.0102678762845,
-0.348015354189          0.000134768599472        0.0281785227667
0.0102678762845          0.257776510526}  ;      /****Enter  Variance-Covariance
Matrix By Row****/
elseif mode ==3;
title = "USA";
/*******  USA  (3) *******/
beta1  =  {-2.61510300,  -0.00835000,  1.40517200,  -0.76526800,  1.69580800};
/****Enter Beta Hats including price****/
mean1 = {1, 0, 3.948905, 2.79562, 0.131387} ;
/**Enter Means in order of Beta Hats, for WTP PUT IN ZERO FOR PRICE ****/
vcov1 = {3.74187407804   -0.000409738186802      -0.619944998467
-0.383051818306          -0.62381449689,
-0.000409738186802       5.90615370467e-06        -8.37782513922e-05
7.32195904212e-05        5.82851267206e-05,
-0.619944998467          -8.37782513922e-05       0.133400968675
0.0272385006846          0.135025903299,
```

```
-0.383051818306          7.32195904212e-05          0.0272385006846
0.0931544122256          0.000290436950456,
-0.62381449689           5.82851267206e-05          0.135025903299
0.000290436950456        0.675403890942} ;      /****Enter  Variance-Covariance
Matrix By Row****/
endif;
pb1= beta1[2,1];              /****Isolates Price Parameter *****/
u1   = beta1'mean1;          /**** Calculates unrestricted grand constant *****/
cvu1 = -u1/pb1;              /**** Calculates  unrestricted WTP point estimate ****/
cvr1 = ln(1+exp(u1))./abs(pb1);    /*** Calculates restricted CV point estimate ****/
k=rows(beta1);                        /**** of parameters****/
r=zeros(2,k);                         /**** 2xK *****/
r[1,.] = r[1,.]+1;
r[1,2] = 0;                           /**** first row means except for price which is
zero*****/
r[1,.]=r[1,.].*mean1';
r[2,2] = 1;                      /****second row a 1 where the price variable would
be*******/
cof=r*beta1;                 /*** a 2x1 vector with the first element the grand constant and
the second element the price parameter*/
var=r*vcov1*r';              /**** 2x2 co-variance matrix of the bivariate normal
distribution for the grand constant and the price parameter****/
```

```
pp=chol(var);                    /*** the squareroot of the above to get standard deviations--
Cholesky decomposition****/
/*print cof; print var; print pp;*/
b = rndn(draws, rows(cof))*pp+cof';  /***a (draw by 2) matrix of bootstrapped grand
constants and price parameters ****/
cvu=((b[.,1])./abs(b[.,2]);                              /*** the bootstrapped unrestricted
WTP ***/
cvr=ln(1+exp(b[.,1])).(abs(b[.,2]));   /*** the bootstrapped restricted WTP ***/
mcvu=median(cvu);  /*** the median bootstrapped unrestricted WTP ***/
mcvr=median(cvr);   /*** the median bootstrapped restricted WTP ***/
cvu=sortc(cvu,1);  /*** the unrestricted wtp sorted ***/
cvr=sortc(cvr,1);  /*** the restricted wtp sorted ***/
cls;
print "WTP FOR LOGIT MODEL - BRANKA PROJECT";
print;
print title;
print; "repetitions used to form CI's = "   draws;
print;
print "point unrestrictive mean ="      cvu1;
print "bootstrapped unrestrictive median  = "  mcvu;
print "bootstrapped 90% confidence intervals = "   cvu[c90,.]';
print "bootstrapped 95% confidence intervals = "   cvu[c95,.]';
```

```
print "bootstrapped 99% confidence intervals = "   cvu[c99,.]';
print;
print;  "point restrictive mean ="  cvr1;
print "bootstrapped resrictive median  = "   mcvr;
print "bootstrapped 90% confidence intervals = "   cvr[c90,.]';
print "bootstrapped 95% confidence intervals = "   cvr[c95,.]';
print "bootstrapped 99% confidence intervals = "   cvr[c99,.]';
stop;
```